

## Accepted Manuscript

Study of Cu<sub>2</sub>CdGeSe<sub>4</sub> monograin powders synthesized by molten salt method for photovoltaic applications

M. Kauk-Kuusik, X. Li, M. Pilvet, K. Timmo, M. Grossberg, T. Raadik, M. Danilson, V. Mikli, M. Altosaar, J. Krustok, J. Raudoja



PII: S0040-6090(18)30624-2  
DOI: doi:[10.1016/j.tsf.2018.09.025](https://doi.org/10.1016/j.tsf.2018.09.025)  
Reference: TSF 36887

To appear in: *Thin Solid Films*

Received date: 13 June 2018  
Revised date: 16 August 2018  
Accepted date: 12 September 2018

Please cite this article as: M. Kauk-Kuusik, X. Li, M. Pilvet, K. Timmo, M. Grossberg, T. Raadik, M. Danilson, V. Mikli, M. Altosaar, J. Krustok, J. Raudoja , Study of Cu<sub>2</sub>CdGeSe<sub>4</sub> monograin powders synthesized by molten salt method for photovoltaic applications. Tsf (2018), doi:[10.1016/j.tsf.2018.09.025](https://doi.org/10.1016/j.tsf.2018.09.025)

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# Study of $\text{Cu}_2\text{CdGeSe}_4$ monograin powders synthesized by molten salt method for photovoltaic applications

M. Kauk-Kuusik<sup>1,\*</sup>

[marit.kauk-kuusik@ttu.ee](mailto:marit.kauk-kuusik@ttu.ee)

X. Li<sup>1</sup>,  
M. Pilvet<sup>1</sup>,  
K. Timmo<sup>1</sup>,  
M. Grossberg<sup>1</sup>,  
T. Raadik<sup>1</sup>,  
M. Danilson<sup>1</sup>,  
V. Mikli<sup>1</sup>,  
M. Altosaar<sup>1,2</sup>,  
J. Krustok<sup>1</sup>,

J. Raudoja<sup>1</sup>

<sup>1</sup> Department of Materials and Environmental Technology, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia.

<sup>2</sup> Division of Physics, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia.

## Abstract

$\text{Cu}_2\text{CdGeSe}_4$  monograin powders were synthesized by molten salt method for photovoltaic applications. The effects of salt material ( $\text{CdI}_2$  and  $\text{KI}$ ), synthesis temperature and time on the structural, morphological, compositional and optoelectronic properties were investigated. Phase analysis by Raman spectroscopy and X-ray diffraction methods showed that the  $\text{Cu}_2\text{CdGeSe}_4$  powder crystals synthesized at 500 °C had tetragonal structure and those synthesized at 600 °C and 700 °C had orthorhombic structure. The band gap values determined from external quantum efficiency measurements were 1.27 eV for orthorhombic  $\text{Cu}_2\text{CdGeSe}_4$  and 1.14 eV for tetragonal  $\text{Cu}_2\text{CdGeSe}_4$  powder crystals. The monograin layer solar cell on the base of orthorhombic  $\text{Cu}_2\text{CdGeSe}_4$  powder showed the best conversion efficiency of 4.21% (active area), with an open-circuit voltage of 0.46 V, a short-circuit current density of 23.3 mA/cm<sup>2</sup> and fill factor of 39%.

**Keywords:** molten salt synthesis-growth; Crystal structure; Solar cells; Copper cadmium germanium selenide

## 1. Introduction

There is a large group of ternary and quaternary copper chalcogenide compounds that have attracted considerable attention due to their suitable properties for thin film solar cell absorbers. Among them  $\text{Cu}(\text{In,Ga})\text{Se}_2$  (CIGSe) based thin film solar cells have been studied for several decades and resulted in power conversion efficiency (PCE) of 22.9% [1]. Another semiconductor material which responds to the requests of using only low-cost, non-toxic and earth-abundant elements is the kesterite  $\text{Cu}_2\text{ZnSn}(\text{S,Se})_4$ . The PCE of the kesterite-based devices has stagnated at a level lower than 13% [2-4] in the last few years, which is much lower than the predicted value from the Shockley-Queisser limit. This difference between CIGSe and kesterite-based solar cell devices has also motivated research on the other quaternary copper chalcogenide compounds with suitable band gap energy for solar cell

Download English Version:

<https://daneshyari.com/en/article/10156109>

Download Persian Version:

<https://daneshyari.com/article/10156109>

[Daneshyari.com](https://daneshyari.com)